

DISTRIBUTION AND HABITAT ASSOCIATIONS OF THREE ENDEMIC GRASSLAND SONGBIRDS IN SOUTHERN SASKATCHEWAN

S. K. DAVIS,^{1,4} D. C. DUNCAN,^{1,2} AND M. SKEEL^{1,3}

ABSTRACT.—We conducted 1675 point counts on 93 survey routes to determine the distribution and habitat associations of three endemic grassland songbirds across the four prairie ecoregions of southern Saskatchewan, Canada. Within the four habitat types surveyed, Sprague's Pipits (*Anthus spragueii*) and Chestnut-collared Longspurs (*Calcarius ornatus*) occurred more frequently in native and seeded pastures than in hayland and cropland, whereas Baird's Sparrows (*Ammodramus bairdii*) occurred as frequently in hayland as in native and seeded pastures. The occurrence of Baird's Sparrows and Chestnut-collared Longspurs did not differ significantly between lightly, moderately, and heavily grazed native pastures, whereas Sprague's Pipits occurred less frequently in heavily grazed pastures. Sprague's Pipits and Chestnut-collared Longspurs occurred more often in the drier prairies of the southern portion of the province, but Chestnut-collared Longspurs were virtually absent from the cypress upland ecoregion. In contrast, Baird's Sparrows occurred most frequently in the semi-arid grasslands of the moist-mixed grassland ecoregion. In native pastures, Chestnut-collared Longspurs were associated with a lower density of short grasses and lesser amounts of litter whereas Baird's Sparrows were associated with a higher density of taller grasses and sparse shrub cover. Our results suggest that conservation programs that convert annually tilled cropland to perennial forage could provide additional habitat for endemic grassland birds. Received 2 Nov. 1998, accepted 2 April 1999.

Land settlement and agriculture have greatly altered the landscape of southern Saskatchewan. Only 17% of the province's original native prairie remains (Samson and Knopf 1994) and is currently threatened by cultivation, over-grazing by livestock, invasion by exotic plant species, and urban development. In areas of Saskatchewan where soils and landscapes are particularly suited for crop production, less than 0.1% of the original native prairie remains (Riemer et al. 1997).

Despite the loss of native grassland, Saskatchewan supports a diverse grassland avifauna (Smith 1996), including 11 of the 12 primary endemic, and 17 of the 25 secondary endemic grassland bird species as outlined by Knopf (1994). Primary endemic species generally have more restricted breeding ranges (Sauer et al. 1997) and are less flexible in their habitat requirements than more broadly distributed species (Owens and Myres 1973, Knopf 1996, Davis and Duncan in press). Consequently, continental populations of 7 of

the 11 primary endemic species are currently in decline (Sauer et al. 1997), possibly as a result of loss and degradation of native prairie habitat.

Information on the habitat associations of endemic songbirds can provide insight into population declines by identifying habitat features that correlate with their occurrence. This information may be used in making management decisions and formulating land-use policies. Although many researchers have examined habitat selection by grassland songbirds (Cody 1968, Owens and Myres 1973, Whitmore 1979, Rotenberry and Wiens 1980, Johnson and Temple 1986, Mahon 1995), little research has been focused on birds of the northern mixed-grass prairie. Furthermore, most studies in the mixed-grass prairie region have been conducted on intensively managed sites (Dale 1983, Winter 1994, Madden 1996, Dale et al. 1997) or were located within a small geographic area (Arnold and Higgins 1986, Sutter 1996; but see Johnson and Schwartz 1993, Davis and Duncan in press).

We examined habitat associations and the distribution of three endemic songbird species of the northern mixed-grass prairie across the entire Prairie Ecozone of southern Saskatchewan. The objectives of the study were (1) to determine whether the frequencies of occur-

¹ Saskatchewan Wetland Conservation Corporation, 202-2050 Cornwall St., Regina SK, Canada, S4P 2K5.

² Present address: Canadian Wildlife Service, 200-4999-98th Ave., Edmonton AB, Canada, T6B 2X3.

³ Present address: Nature Saskatchewan, 206-1860 Lorne St., Regina SK, Canada, S4P 2L7.

⁴ Corresponding author; E-mail: sdavis@wetland.sk.ca

rence of Sprague's Pipit (*Anthus spragueii*), Baird's Sparrow (*Ammodramus bairdii*), and Chestnut-collared Longspur (*Calcarius ornatus*) differ among native pasture, seeded pasture, hayland, and cropland; (2) to determine whether various levels of grazing intensity influence the occurrence of these species; (3) to determine the distribution of the three species relative to the prairie ecoregions of Saskatchewan; and (4) to identify structural components of native prairie vegetation important in predicting songbird occurrence.

STUDY AREA AND METHODS

Study area.—We conducted grassland bird surveys throughout the Prairie Ecozone of southern Saskatchewan. The Prairie Ecozone covers 24,103,000 ha and comprises four ecoregions: cypress upland, mixed grassland, moist-mixed grassland, and aspen parkland (Fig. 1; Ecological Stratification Working Group 1995). The cypress upland in the extreme southwestern portion of the province rises 400–500 m above the prairie landscape. This region is characterized by sloping escarpments, valleys, and coulees. Wheatgrass (*Agropyron* spp.) and speargrass (*Stipa* spp.) dominate the dark brown soils of the lower elevations, whereas fescue (*Festuca* spp.) prairie predominates on the slopes and at higher elevations. The mixed grassland is the driest region of Saskatchewan and is characterized by wheatgrass, speargrass, and blue grama grass (*Bouteloua gracilis*). Because of the lack of moisture, trees and wetlands are scarce; shrubs are restricted to mesic areas. The moist-mixed grassland represents the northern extent of the open grasslands in Saskatchewan. This region is characterized by semiarid conditions and dark brown soils. Speargrass, wheatgrass, and deciduous shrubs predominate. The aspen parkland ecoregion is characterized by trembling aspen (*Populus tremuloides*) groves and fescue grasslands, although the latter habitat is now rare (Sask. Wetland Conserv. Corp., unpubl. data).

Bird surveys were conducted in native pasture, seeded pasture, hayland, and cropland. Survey routes were designed to sample mostly grassland habitat, although each of the four habitat types was sampled on most routes. Native prairie was characterized by *Stipa* spp., June grass (*Koeleria cristata*), northern wheatgrass (*Agropyron dasystachyum*), western wheatgrass (*A. smithii*), blue grama grass, *Carex* spp., club moss (*Selaginella densa*), pasture sage (*Artemisia frigida*), and various forbs. The most common shrubs were western snowberry (*Symphoricarpos occidentalis*), rose (*Rosa* spp.), and wolf willow (*Eleagnus commutata*). Seeded pasture was defined as land that had been broken and seeded with exotic perennial grasses for grazing, most commonly crested wheatgrass (*Agropyron cristatum*) or brome grass (*Bromus* spp.), with alfalfa (*Medicago* spp.) or sweet clover (*Melilotus* spp.) sometimes present. Hayland was defined as cultivated land that had

been seeded to perennial crops for haying. Vegetation on hayland ranged from 100% alfalfa, to mixes of alfalfa, sweet clover and introduced grasses such as brome grass, crested wheatgrass, or bluegrass (*Poa* spp.). Cropland was cultivated land that was seeded to annual crops, most commonly wheat (*Triticum aestivum*) or canola (*Brassica* spp.).

Route selection.—We numbered (1–42) townships from the U.S. border to the northern extent of the aspen parkland, and renumbered (1–64) range locations from the Manitoba border west to the Alberta border. The starting points of 76 routes were then located by selecting township-range numbers from a random number table. Because the target species (Baird's Sparrow) was believed to be a grassland specialist (Cartwright et al. 1937, Owens and Myres 1973), we only included townships where most point counts ($\geq 80\%$) could be located in grassland habitat. Thus more routes were established in the mixed grassland ecoregion than the other ecoregions because most of the grassland in Saskatchewan exists in this region (Saskatchewan Digital Land Cover Project, unpubl. data). Because Baird's Sparrow was a threatened species in 1994 (Goossen et al. 1993), we assumed they were uncommon and established an additional 19 non-random routes in areas where the species was thought to occur regularly. The proportion of point counts in grassland habitat was nearly identical for random and non-random routes (79 and 80%, respectively).

Bird occurrence.—Six surveyors recorded the number of singing males using five-minute, 100-m fixed radius point counts (Ralph et al. 1993) conducted from roads and trails at approximately 0.8 km intervals along each route. Each point count was subdivided into half-circle counts by recording birds detected on the left or right side of the road or trail because habitat types and grazing intensity often differed on each side. Although roadside sampling may confound species-habitat associations because of the influence of roadside vegetation, the three species in this study are not attracted to roadside habitat (Sutter et al., in press). Thus the occurrence of these species in the four habitat types is likely not confounded by roadside vegetation. Surveyors attended a training session prior to the study to standardize protocol and reduce surveyor bias. Surveys were conducted between 4 June and 2 July, 1994, commenced 30 minutes before sunrise, on days with no precipitation, and winds less than 20 km/hr. Each route had 20–25 stops.

Habitat associations.—Bird surveyors quantified eight measures of vegetation structure at every second native pasture point count location on the same day as the survey. Vegetation was assessed on only native pastures because of logistic constraints in sampling all habitats over a large area and because of our increased sampling of native pasture. Each surveyor laid a meter stick on the ground at least 35 m from the road/trail at a random location within each portion of the half-circle. A 6 mm diameter metal rod was passed vertically through the vegetation at each end of the meter stick and the number of contacts by different vegeta-

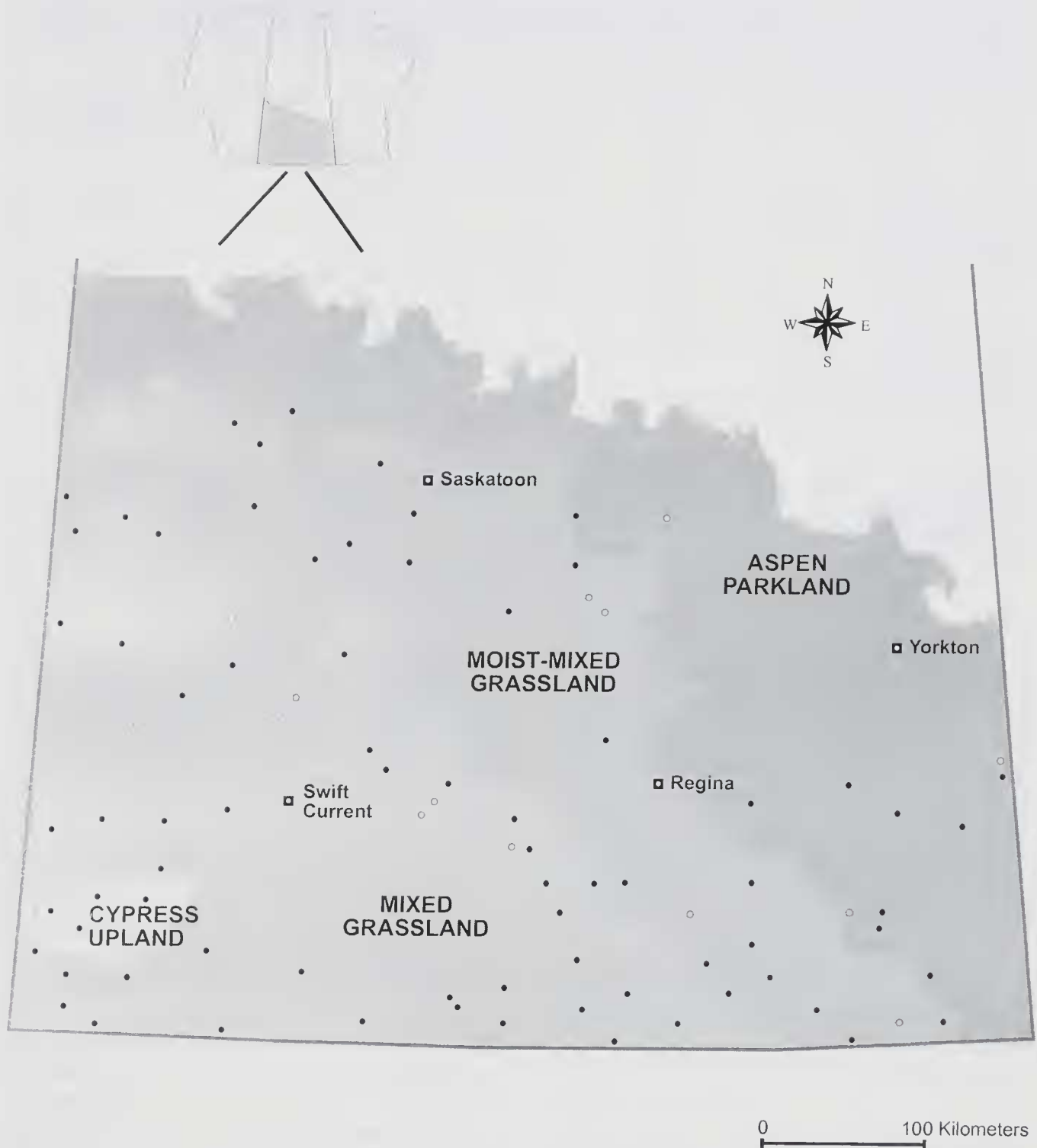


FIG. 1. Location of random (closed circles) and non-random (open circles) survey routes and ecoregions within the Prairie Ecozone of southern Saskatchewan.

tive life forms (e.g., standing dead vegetation, narrow-leaf grass, broad-leaf grass, forb, shrubs >15 cm, and dwarf shrubs <15 cm high) counted in each successive 1 decimeter (dm) height interval (Rotenberry and Wiens 1980). The occurrence of each life form was lumped into two height categories; 1 dm (number of contacts ≤ 1 dm) and 2+ dm (number of contacts >1 dm) height intervals because vegetation contacts in native pastures rarely occurred in the higher levels. Litter depth was measured from the surface of the ground to

the top of the litter, and distance to the nearest shrub was visually estimated.

Grazing intensity was estimated in June and early July by a range ecologist as idle, lightly, moderately, or heavily grazed. Idle prairie was defined as native vegetation that had not been grazed for at least two years. Heavily grazed pastures were characterized by virtually all plant material and litter removed, greater than 20% bare soil, greater than 40% club moss, and small plants with poor vigor. Lightly grazed pasture

TABLE 1. Influence of habitat type, ecoregion, and grazing intensity on the occurrence (% half circles) of singing males in southern Saskatchewan. For each species, values followed by the same letter do not differ ($P > 0.05$) from one another.

	Sprague's Pipit	Baird's Sparrow	Chestnut-collared Longspur
Habitat			
Native pasture ($n = 1158$)	18.5 A	30.5 A	21.4 A
Seeded pasture ($n = 192$)	14.1 A	31.2 A	17.7 A
Hayland ($n = 116$)	2.6 B	25.0 A	1.7 B
Cropland ($n = 209$)	0.5 B	5.3 B	0.5 B
Ecoregion			
Aspen parkland ($n = 238$)	8.4 A	15.9 A	6.7 A
Cypress upland ($n = 149$)	24.2 B	16.8 A	2.0 B
Mixed grassland ($n = 805$)	16.9 B	25.8 B	24.4 C
Moist-mixed grassland ($n = 483$)	6.2 A	37.7 C	14.5 D
Grazing intensity			
Lightly grazed ($n = 112$)	19.6 A	34.8	23.2
Moderately grazed ($n = 137$)	22.6 A	37.9	24.1
Heavily grazed ($n = 81$)	9.9 B	25.9	22.2

was defined as having little evidence of grazing, abundant litter and plant material, less than 10% bare soil, less than 10% club moss, and robust and vigorous plants. Moderately grazed pastures exhibited characteristics intermediate between the previous two types.

Statistical analyses.—We used songbird occurrence (presence/absence) within half-circle point counts for all analyses because more than one individual was recorded in only 9%, 8%, and 2% of the half-circle counts for Baird's Sparrow, Chestnut-collared Longspur and Sprague's Pipit, respectively. Because the two half-circle counts at any given stop do not represent independent observations, we randomly chose only one half-circle count on either side of the road or trail for inclusion in all subsequent analyses. χ^2 contingency analyses were used to determine whether the frequency of occurrence of songbirds inside half-circle point counts was influenced by land-use, grazing intensity, and ecoregion. Pair-wise comparisons were performed only for those species where the overall significance level was $P < 0.05$. Although most of the native and seeded pastures were grazed by cattle, 5% of the sample points had been idle for at least two years and were thus omitted from all analyses. A multivariate assessment of songbird occurrence in native pasture was conducted using step-wise logistic regression on half-circle point counts using vegetative structure, grazing intensity, and ecoregions. None of these variables were highly correlated with each other (all comparisons $r^2 < 0.42$, $P > 0.001$) except for the number of contacts of broad-leaf grass in the first, and 2+ decimeter categories ($r^2 = 0.71$, $P < 0.001$); thus only broad-leaf grass contacts in the first decimeter were used. Level of significance for variable inclusion in the models was set at 0.05. All analyses were performed using SAS statistical software v. 6.12 (SAS Institute Inc. 1989).

RESULTS

Land use.—The occurrence of each of the three endemic species differed significantly among habitat types ($\chi^2 = 59.2-75.6$, $df = 3$, $P < 0.001$). Sprague's Pipit and Chestnut-collared Longspur occurred more frequently in native and seeded pasture than in hayland or cropland, whereas Baird's Sparrows occurred as frequently in native and seeded pastures as in hayland, but occurred least frequently in cropland (Table 1).

Distribution.—The occurrence of each species differed among ecoregions (Table 1; $\chi^2 = 51.1-74.4$, $df = 3$, $P < 0.001$). Furthermore, ecoregion type was a significant predictor of occurrence in each of the three logistic regression models (Table 2). Sprague's Pipits were recorded in relatively low abundance throughout the study area, occurring most frequently in the cypress upland and mixed grassland ecoregions (Table 1). Chestnut-collared Longspurs were primarily restricted to the extreme southern portion of the province, particularly within the mixed grassland ecoregion (Tables 1, 2). Baird's Sparrows were abundant throughout much of the study area, but were recorded most frequently in the moist-mixed grassland (Tables 1, 2).

Habitat associations.—Grazing intensity had little influence on the occurrence of

TABLE 2. Results summary of step-wise logistic regression analyses of grassland songbird occurrence in native pasture. Variables are presented in the order they were entered into the model.

Species	Variable	Parameter estimate	Wald χ^2	P	R ²
Sprague's Pipit	Intercept	-0.894	19.922	<0.001	0.092
	Moist-mixed grassland	-1.920	12.377	<0.001	
	Heavily grazed	-0.981	4.261	0.039	
Baird's Sparrow	Intercept	-1.346	26.653	<0.001	0.075
	Narrow-leaf grass 2 ⁺ dm	0.315	9.480	0.002	
	Moist-mixed grassland	0.825	8.209	0.004	
	Shrub distance	0.008	3.941	0.002	
Chestnut-collared Longspur	Intercept	-0.605	3.664	0.055	0.088
	Litter depth	-0.035	4.525	0.033	
	Narrow-leaf grass 1 dm	-0.278	6.053	0.014	
	Mixed grassland	0.675	4.535	0.033	

Baird's Sparrow and Chestnut-collared Longspur in native pasture (Table 1; $\chi^2 = 3.4$, $df = 2$, $P > 0.05$ and $\chi^2 = 0.1$, $df = 2$, $P > 0.05$, respectively). The occurrence of Sprague's Pipits in native pasture differed significantly among grazing intensity levels ($\chi^2 = 6.2$, $df = 2$, $P = 0.045$). Sprague's Pipits were negatively associated with heavy grazing (Table 2), occurring twice as often in lightly and moderately grazed pastures as in heavily grazed pastures (Table 1). Although grazing intensity did not significantly influence the occurrence of Baird's Sparrows, the species was associated with pastures having greater coverage of grasses over 10 cm and were attracted to pastures with sparse shrub cover (Table 2). In contrast, Chestnut-collared Longspurs appeared to be associated with pastures that were characterized by less dense vegetative cover. The species was negatively associated with depth of the litter and the density of narrow-leaf grasses in the first decimeter (Table 2). However, the amount of variation explained by each model was extremely poor (Table 2).

DISCUSSION

Land-use.—Sprague's Pipits and Chestnut-collared Longspurs were mostly restricted to grassland habitat in southern Saskatchewan. Although we detected no differences in the frequency of occurrence of these species in native and seeded pastures, others have reported Sprague's Pipits (Owens and Myres 1973, Hartley 1994, Madden 1996, Dale et al. 1997) and Chestnut-collared Longspurs (Stewart and Kantrud 1972, Owens and Myres

1973) to prefer native prairie over a number of other habitat types. The attractiveness of seeded pastures in this study may have been influenced by the age and structural composition of the seeded pastures such that a number of these pastures may have been similar to native pastures. Indeed, surveyors consulted with the range ecologist on several occasions to confirm whether pastures were native or had been cultivated in the past. More recently seeded pastures, or those dominated by certain exotic plant species may be less suitable for Sprague's Pipits and Chestnut-collared Longspurs. In Saskatchewan, both species occur more frequently and in higher abundance in native pastures than in pastures dominated by crested wheatgrass (Sutter 1996, Davis et al. 1996, Davis and Duncan in press). Similarly, fields comprised predominantly of smooth brome grass (*Bromus inermis*) are unsuitable for these species (Wilson and Belcher 1989).

In our study, Baird's Sparrows exhibited more flexibility in their habitat use than either Chestnut-collared Longspurs or Sprague's Pipits. The occurrence of Baird's Sparrows in habitats other than native prairie has been well documented (reviewed in Davis et al. 1996) despite earlier studies that suggested the sparrow was a native prairie specialist (Cartwright et al. 1937, Owens and Myres 1973). Although we frequently recorded Baird's Sparrows in hayfields, this habitat may act as a population sink (Pulliam 1988). Using a productivity index, Dale and coworkers (1997) found significantly fewer signs of productive

behavior following mowing of hayfields in southern Saskatchewan. Mowing destroys approximately 50% of ground nests and the productivity of breeding birds in hayfields is often below that required to maintain a stable population (Frawley 1989, Bollinger et al. 1990).

Distribution and habitat associations.—We found that the distribution of Sprague's Pipit, Baird's Sparrow, and Chestnut-collared Longspur closely resembled that outlined by the Saskatchewan breeding bird atlas (Smith 1996) and the Breeding Bird Survey (BBS; Sauer et al. 1997). Additionally, our results suggest that these species are associated with certain regions within the Prairie Ecozone. Sprague's Pipits and Chestnut-collared Longspurs occurred mostly in the drier prairies of the southern portion of the province, but Chestnut-collared Longspurs were virtually absent from the cypress upland ecoregion despite the presence of large tracts of native grassland. Grassland habitat in this region is taller and denser than the surrounding grasslands (W. Harris, pers. comm.) and thus may not provide Chestnut-collared Longspurs with the short, sparse vegetative cover they require (Harris 1944, Owens and Myres 1973, Dale 1983). In contrast to Sprague's Pipits and Chestnut-collared Longspurs, Baird's Sparrows occurred most frequently in the more mesic grasslands of the moist-mixed grassland ecoregion, consistent with their overall preference for taller and denser vegetation (Dale 1983, Winter 1994, Madden 1996, Sutter and Brigham 1998, Davis and Duncan in press). Furthermore, our study indicates that the Missouri Coteau, which borders the mixed and moist-mixed grassland ecoregions, is an important landform for Baird's Sparrows in Saskatchewan (McMaster and Davis, unpubl. data). This landform has also been identified as a significant region for Baird's Sparrows in North Dakota (Stewart 1975).

Grazing by livestock can have a profound influence on the structure of rangeland vegetation (Wiens and Dyer 1975, Ryder 1980). Because habitat selection by grassland birds is likely influenced by habitat structure (Wiens 1969), grazing intensity should affect the occurrence of the three songbird species examined in this study. Sprague's Pipits, and to a lesser degree, Baird's Sparrows, were both in-

fluenced by grazing intensity. Light to moderately grazed pasture has been described as preferred habitat for both Sprague's Pipits and Baird's Sparrows (Kantrud 1981; Kantrud and Kologiski 1982, 1983; Knopf 1996) although others have suggested that these species prefer idle prairie (Maher 1973, Owens and Myres 1973, Dale 1984). The latter studies, however, examined only a small number of grazed and ungrazed sites and did not discriminate between lightly or heavily grazed pastures. We could not assess the suitability of ungrazed prairie to either species in our study because this habitat type is uncommon in Saskatchewan. Despite the lack of information on the response of Sprague's Pipits and Baird's Sparrows to low intensity grazing relative to ungrazed native prairie, our results suggest that low levels of grazing intensity are tolerated by these species.

We found no difference in the response of Chestnut-collared Longspurs to grazing intensity in native pasture. Numerous studies have reported that Chestnut-collared Longspurs respond positively to grazing (Maher 1973, Dale 1983, Kantrud and Kologiski 1983, Renken and Dinsmore 1987, Bock et al. 1993). Grazing may not have influenced Chestnut-collared Longspurs in our study because the structure of the vegetation under all grazing intensities may have fallen within an acceptable range. Descriptions of Chestnut-collared Longspur breeding habitats have ranged from overgrazed pastures with sparse vegetation to situations where the "...thicker and taller grasses afford adequate concealment" (DuBois 1935:70). Chestnut-collared Longspurs in our study were generally associated with sparsely vegetated native pastures with low plant litter depths (see also Harris 1944, Owens and Myres 1973, Dale 1983, Johnson and Schwartz 1993).

Conservation.—While continental populations of Baird's Sparrows and Chestnut-collared Longspurs appear to be relatively stable (Sauer et al. 1997), Sprague's Pipits are currently undergoing significant population declines of 4.7% per year, one of the steepest declines recorded for grassland songbirds in North America. The conversion of native grassland to annually cropped land, and the pattern of habitat loss (i.e., habitat fragmentation) have likely played significant roles in

these declines (Davis, unpubl. data). For example, Sprague's Pipits reach their highest densities in southeastern Alberta and southwestern Saskatchewan (Sauer et al. 1997), areas characterized by large tracts of contiguous native grassland (South Digital Land Cover Project, unpubl. data). While land-use programs that convert annually tilled cropland to perennial cover will likely provide additional habitat for endemic grassland birds (Johnson and Schwartz 1993, Reynolds et al. 1994, Sutter and Brigham 1998, Davis and Duncan in press), it is imperative that the reproductive consequences of selecting alternative nesting habitats be determined to accurately assess habitat quality (Johnson and Temple 1986, Van Horne 1983, Vickery et al. 1992).

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